REMARKS

Claims 13-26 are active in the case. Claims 9-11 are withdrawn from consideration. Reconsideration is respectfully requested.

Applicants representative wishes to thank Examiners Song and Alanko for the helpful and courteous interview of April 20, 2004. As a result of the discussion, it is believed that the issues in the case have been clarified and that the prosecution of the application has been materially advanced.

Claim Amendments

Claims 13 and 19 have been amended to recite that the feedstock gas consists of a silicon source gas, a carbon source gas and optionally at least one carrier gas of hydrogen or a noble gas. The fact that the feedstock gas may contain an inert rare gas or hydrogen is supported by the last several lines of text on page 13 and by the discussion of Embodiment B on page 21 of the text. In view of the full support for the amending language entry of the amendment into the record is respectfully requested.

Claim Rejection, 35 USC 112, First Paragraph

The issue raised with respect to Claims 13 and 19 concerning the term "dopant-free" is obviated by the cancellation of the term from the preamble of each claim. Withdrawal of the rejection is respectfully requested.

Invention

One aspect of the present invention is a method of manufacturing a single crystal of silicon carbide, by forming a single crystal of silicon carbide on a substrate surface at a temperature of not less than 900° C from a feedstock gas atmosphere consisting of at least a silicon source gas and a carbon source gas under the atmospheric condition of the partial pressure (ps) of the silicon source gas being held constant (at ps>0) and the partial pressure of the carbon source gas in the atmosphere repeatedly alternating between state pc1 present at an interval of time (tc1) and the state pc2 present at an interval of time (tc2) until the single crystal of silicon carbide is completely formed, where pc1>pc2 such that the partial pressure ratio (pc1/ps) falls within the range of 1-10 times the attachment coefficient ratio (Ss/Sc) and the partial pressure ratio (pc2/ps) falls within the range of less than once the attachment coefficient ratio (Ss/Sc).

A second aspect of the invention is a method of manufacturing a single crystal of silicon carbide on a substrate surface at a temperature of not less than 900° C from a feedstock gas atmosphere consisting of at least a silicon source gas and a carbon source gas under the atmospheric condition of the partial pressure (pc) of the carbon source gas being held constant (at pc>0) and the partial pressure of the silicon source gas in the atmosphere repeatedly alternating between state ps1 present at an interval of time (ts1) and the state ps2 present at an interval of time (ts2) until the single crystal of silicon carbide is completely formed, where ps1<ps2 such that the partial pressure ratio (pc/ps1) falls within the range of 1-10 times the attachment coefficient ratio (Ss/Sc) and the partial pressure ratio (pc/ps2) falls within the range of less than once the attachment coefficient ratio (Ss/Sc).

Prior Art Rejection, 35 USC 103(a)

Claims 13-15, 19-21, 25 and 26 stand rejected based on 35 USC 103(a) as obvious over Larkin et al, U. S. Patent 5,709,745. This ground of rejection is respectfully traversed.

Applicants maintain their position on the record that the Larkin et al patent does not suggest the present invention. It is clear from a consideration of the Larkin et al disclosure that the objective of the patent, and consequently the methodology disclosed therein for forming a SiC product are quite different from the objective and methodology of the present invention. Note that the context of the invention of the patent is stated at column 6, lines 41-44 of the patent, where the inadequacy of prior art techniques of controlling the dopant and/or contaminant incorporation into crystals grown by the CVD process is stated. Accordingly, as stated in the summary of the invention of the patent, patentees provide a method of controlling the amount of selected element, i.e., dopant or contaminant, that is incorporated in the gaseous reactants that contain silicon and carbon that are necessary for the growth of a doped SiC product. As stated at column 6, lines 59-67 of the patent

> -- The improvement (of the method of the patent) comprises flowing a first amount of a gaseous Si compound through the growth chamber and flowing a second amount of gaseous C compound through the growth chamber and **controlling the ratio of the first amount of Si compound relative to the second amount of C compound to control the amount of the selected element deposited in the SiC crystal** at the crystal growth area. The selected element is an impurity and is either a dopant or a contaminant. --

The mechanism of the patent by which a silicon carbide material is grown that is doped or contains a contaminant is discussed in the paragraph of columns 16 and 17. That is,

> -- The additional degree of control over dopant incorporation is carried out by manipulating the demand of a particular dopant at Si site 82 or C site 80 during the film layer growth. During the growth of each SiC film layer,

> the rate at which a layer of Si atoms 86 and C atoms 84 are formed depends on the availability of atoms and/or molecules that can fill a particle site in the Si atom 86 or C atom layer 84. When the concentration of C atoms in the reaction chamber is increased relative to the Si atom concentration, the demand for atoms to fill C sites 80 decreases since the available amount of C atoms has increased. As a result, the C atom layer 84 is formed at a faster rate and C sites 80 are disproportionately filled with C atoms. However, the relative increase in C atoms effects a relative decrease in Si atoms available to fill Si sites 82. **The relative decrease in available Si atoms results in a slower filling of Si sites 82 and a greater demand for any type of atom or molecule to fill Si site 82. The greater Si site demand results in an increase in non-Si atoms (dopants, contaminants) filling Si sites 82 to form Si atom layer** 86. ... --

From the discussion above it is clear that in the process of the patent for forming a silicon carbide product, the flow of Si and C containing gases into a reaction chamber is done in relation to the flow of dopant or contaminant material in order to achieve the proper level of doping or contamination of the SiC product produced. In this process, there is no concept of the present invention where the flow of Si containing feed gas is controlled relative to the flow of C containing feed gas only without the presence of a dopant or contaminant material to prepare an undoped SiC product at a greater rate of growth. At this point it is important to note that the present claims require a feed gas that **consists of** two components only which are a Si containing feed gas and a C containing feed gas. **No** dopant or contaminant gas component is present in the gases sent to the reaction chamber of the present process. Accordingly, the process of the present invention as claimed in the embodiments Claims 13 and 19 is not shown or suggested by Larkin et al.

Applicants also refer to Example 11 of the patent. Here, the preparation of a p-type doped SiC material is described where the flows of trimethylaluminum and silane were held constant while the flow of propane as the source of carbon was varied to effectively control the Si/C ratio

in the growth reactor. By effectively increasing the Si/C carbon ratio, aluminum was excluded from the SiC epilayer that was formed. Clearly, the flows of both the Si containing gas and the C containing gas are dependent upon or a function of the amount (flow) of dopant or contaminant material into the reactor in which a SiC product is formed. Note that Ex 11 of the patent describes that by holding the flows of nitrogen gas and silane constant, while varying the flow of propane, the dopant profile of nitrogen (n-type dopant) was controlled. This process embodiment is clearly not the same as, nor does it suggest, the process embodiments of the present invention where, in the case of Claim 13, the partial pressure of silicon feed gas (ps) at ps>0 was maintained constant, while the partial pressure of C feed gas was **repeatedly alternated** between pressure states pc 1 and pc 2 at the indicated time intervals (tc 1 and tc 2), and in the case of Claim 19, the partial pressure of carbon feed gas (pc) at pc>0 was maintained constant, while the partial pressure of Si feed gas was **repeatedly alternated** between pressure states ps 1 and ps 2 at the indicated time intervals (ts 1 and ts 2). Accordingly, the Larkin et al patent does not show or suggest the present invention as claimed in any of its embodiments and withdrawal of the indicated ground of rejection is respectfully requested.

Claims 16-17 and 22-23 stand rejected based on 35 USC 103(a) as obvious over Larkin et al, U. S. Patent 5,709,745 in view of Sugiyama et al U. S. Patent 5.964,944. This ground of rejection is respectfully traversed.

The clear and substantial distinction of the present invention over the Larkin et al patent has been discussed above.

The cited Sugiyama et al patent in no way improves upon the deficiencies of Larkin et al. Sugiyama et al discloses a method of producing high purity silicon carbide single crystal by

a reacting silicon vapor directly with a carbon-containing gas under a heated atmosphere. As shown in the figure of the patent, silicon is vaporized in a container into which a carbon containing gas is passed. There is no attempt at maintaining the partial pressure of Si in the device constant and certainly no teaching or suggestion of repeatedly alternating the partial pressures of carbon containing gas relative to a fixed partial pressure of silicon containing feed gas, or vice versa, as required by the present claims. Accordingly, because present Claims 16, 17, 22 and 23 require the specific use of the seed crystal prepared by the methods of present Claims 13 and 19, it is clear that the combined references, which do not teach the method by which the seed crystal of the invention is prepared, do not suggest the methods of manufacturing silicon carbide of the rejected claims. Withdrawal of the rejection is respectfully requested.

Claims 18 and 24 stand rejected based on 35 USC 103(a) as obvious over Larkin et al, U. S. Patent 5,709,745 in view of Gardener et al U. S. Patent 5.964,944. This ground of rejection is respectfully traversed.

Applicants retain their position that the Larkin et al patent does not teach all of the limitations of present Claim 18 (and 24), because the seed crystals of these claims rely upon the method embodiments of Claims 13 and 19 to produce SiC . Because the seed crystals used in the methods of Claims 18 and 24 are prepared by the distinctly different method of the present invention, the seed crystals of the invention result in a different manufactured composite material in comparison to other known products in which a diamond of gallium nitride structure is formed on a SiC seed crystal. Accordingly, withdrawal of the rejection of these claims is respectfully requested.

It is now believed that the application is in proper condition for allowance. Early notice to this effect is earnestly solicited.

Respectfully submitted,

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